FOOD AND FEEDING HABITS OF LARGE SCALE GURNARD, *LEPIDOTRIGLA CAVILLONE* (TRIGLIDAE) IN GREEK SEAS

by

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ABSTRACT. - The feeding spectrum analysis of 1437 stomachs of large scale gurnard, *Lepidotrigla cavillone*, collected from summer 1977 to spring 1978 in four different regions of Greek seas suggested that it feed as an active predator just above the bottom, utilizing mainly nektonic or epibenthic invertebrates. The food habits of this species were rather similar in all studied regions throughout the year. Mysids constitued the most important food resource during all seasons either by weight, number or frequency of occurrence. Decapods were the second most important food group, while amphipods were the third most numerous. In winter, decapods decreased in importance, while mysids increased by weight. The feeding of large scale gurnard exhibited only slight seasonal variation in the principal preys. The small variation of overlap values between seasons and between regions suggested no seasonal or regional variation in prey availability.

RÉSUMÉ. - L'analyse du régime alimentaire de 1437 *Lepidotrigla cavillone*, pêchés depuis l'été 1977 jusqu'au printemps 1978 dans quatre régions des mers grecques, suggère que cette espèce se nourrit, comme prédateur actif juste au-dessus du fond, surtout d'invertébrés nectoniques ou épibenthiques. Les habitudes alimentaires de cette espèce sont semblables dans toutes les régions étudiées et pendant toute l'année. Les mysidacés constituent en toute saison l'apport alimentaire le plus important aussi bien en poids qu'en nombre d'individus ou en fréquence. Les décapodes forment le second groupe alimentaire et les amphipodes le troisième. En hiver, les décapodes ont moins d'importance, tandis que les mysidacés augmentent en poids. L'alimentation de *L. cavillone* ne montre que de petites variations saisonnières en ce qui concerne les proies principales. Les faibles changements des valeurs de recouvrement entre saisons et entre régions suggèrent qu'il n'y a pas de variations saisonnière et régionale dans la disponibilité des proies.

Key-words: Triglidae, *Lepidotrigla cavillone*, MED, Greece, Stomach content, Feeding behaviour.

Feeding and searching for food are factors which regulate or at least influence the distribution, migration and growth of fish. According to food availability, fish can change both their behaviour and migration pattern. Large scale gurnard, *Lepidotrigla cavillone* (Lacépède, 1801), is among the most abundant triglid fish species in demersal communities in Greek seas (Papaconstantinou, 1982, 1983). In order to know the role of this species on the benthic communities, including competitive-predatory relationships, more data on its food habits are required. Little has been published about the feeding of large scale gurnard along the Mediterranean coasts. Kartas (1971) studied the prey species composition in large scale gurnard stomachs in the Gulf of Lion. Caragitsou and Papaconstantinou (1988) gave some preliminary information regarding the diet of this species in Greek seas.

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The purposes of our paper are to describe the general feeding ecology of large scale gurnard, and to compare its food habit and seasonality of feeding among sea areas of different latitudes.

MATERIAL AND METHODS

A total of 1434 stomach contents from large scale gurnard were collected during a bottom trawl survey in Greek seas (Fig. 1) from summer 1977 to spring 1978. The fishes were taken during day time in four areas: the Saronikos Gulf (437), the Pagassitikos Gulf (270), the Thermaikos Gulf (303) and the Thracian Sea (427). The four geographical areas present substantial hydrological and ecological differences expressed mostly as differences in salinity, temperature, greatest depth, kind of sea-floor, presence or absence of river mouth and fishery activity. The hydrology of these areas has been described fully in recent years by different authors. Papaconstantinou (1982, 1983) studied in depth the differences in biology of large scale gurnard and the ecology of gurnards in these areas.

The day-time rhythm of feeding was examined in the Saronikos Gulf before the design of the sampling. The lowest percentage of fishes having stomach contents occurred between midnight and 08.00 and the highest from 10.00 to the following midnight, indicating that most feeding activity occurred between the morning and noon. This is in agreement with Ross (1977), who reported that searobins in Tampa bay (Florida) fed mainly during daytime.

For each fish, the fork length (FL) and the wet weight were noted. Within one hour after fishing, the stomachs were fixed and preserved in 4% formalin for further analysis in the laboratory. The fishes with signs of regurgitation, i.e. food

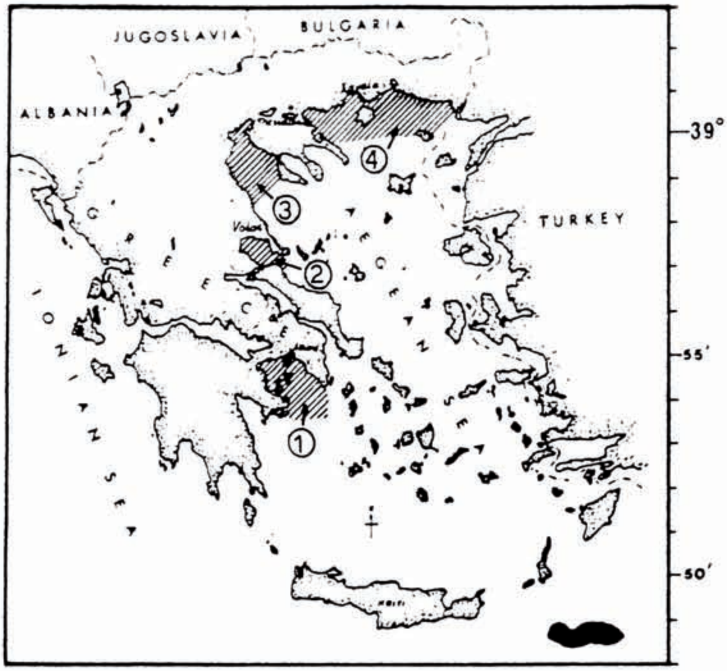

Fig. 1: Map of the sampling areas in the Greek seas: (1) Saronikos Gulf, (2) Pagassitikos Gulf, (3) Thermaikos Gulf, (4) Thracian Sea.

items in the mouth or gill plates, were discarded.The preserved stomachs were individually opened and emptied onto a 0.25 mm mesh opening screen sieve to permit washing without loss of any food items. Individual food organisms were identified as far as possible under a stereomicroscope, counted and measured. For each fish specimen, the weight of each prey group was determined to the nearest 0.01 g. A stomach was considered empty when the food items could not be identified and the material found in the stomach weighed less than 0.01 g.

Frequency of occurrence (% f), weight percentage of total stomach contents (% W), number percentage of total prey number (% N) and the index of relative importance [$IRI = f(\%N + \%W)$] (Pinkas *et al.*, 1971) were calculated for major categories of prey items in each size group for each season and geographical area. The weight percentage was used for the analysis of food spectrum. The reasons of this preference have been discussed deeply by Papaconstantinou and Caragitsou (1987).

Based on a review of dietary overlap measures (Wallace, 1981; Linton *et al.*, 1981), Schoener's (1970) index was chosen. It was found to measure the overlap accurately over most of the range of the potential overlap. Schoener's index, Cxy is calculated as:

$$Cxy = 1.0 - 0.5 \left(\sum[Px,i - Py,i]\right).$$

where Px,i and Py,i are the estimated proportions by weight of prey i in the diets of respectively species x and y (the percentage by weight of prey item). This coefficient has a minimum of 0 (no overlap of prey) and a maximum of 1 (all items in equal proportions). Schoener's index values above 0.60 are usually considered to be "biologically significant" (Zaret and Rand, 1971; Wallace, 1981).

The two factors that may affect the diet of large scale gurnard have been analyzed: season and geographical area. The size was not investigated owing to its narrow range (95-135 cm). Each factor was subdivided into some classes to elucidate the general trends within each factor. Of the 1434 stomachs examined, 211 were empty. The proportion of empty stomachs was similar in the various areas, with a lower proportion of empty stomachs in summer and a larger one in winter. The data on the empty stomachs and the mean weight of the stomach contents were analysed statistically, in order to detect possible seasonal or geographical differences in feeding.

RESULTS

General feeding trends

The list of prey organisms recorded from the large scale gurnard digestive tracts is given on Table I. Because most of the food organisms were unidentifiable below the level of class or order, an abbreviated list of taxa was used for the presentation of the food habits by region and season. Despite some seasonal variation, the ranking of the principal components did not change significantly (1- mysids, 2- decapods, 3- amphipods, 4- cumaceans). In general, the food habits of the species were rather similar in all studied areas throughout the year. The feeding spectrum analysis of large scale gurnard suggested that it fed as an active predator just above the bottom, preying mainly on nektonic or benthic invertebrates.

Differences between geographical areas

Prey composition and availability may be functions of type of sediment, depth and season. The first two parameters characterized each geographical area. The mean weights of individual stomach contents were calculated for each area (Table II): Saronikos 0.127 g; Thracian Sea 0.103 g; Thermaikos 0.088 g and Pagassitikos 0.067 g, and were significantly different in the four study areas ($P < 0.05$). To investigate these differences further, we tested ("t" test) for geographical variation between areas. We found no significant difference between the Thermaikos Gulf and the Thracian Sea ($P > 0.05$); however, there were significant diet differences between the Saronikos Gulf and all the other areas ($P < 0.05$) and between the Pagassitikos and the Thracian Sea and the Thermaikos Gulf ($P < 0.05$).

TABLE I: Invertebrates and fishes recorded in stomachs contents of large scale gurnards in Greek seas.

POLYCHAETA
Aphroditidae
Nephtydae
Nephtys sp.
COPEPODA
Euterpina sp.
OSTRACODA
EUPHAUSIACEA
Thysanopoda aequalis
DECAPODA
Processidae
Processa canaliculata
Crangonidae
Crangon crangon
Pontophilus fasciatus
Penaeidae
Amalopenaus elegans
Palaemonidae
Leander sp.
Galatheidae
Galathea intermedia
Porcellanidae
Porcellana longicornis
BRACHYURA
Portunidae
Portunus depurator
Porturus sp.
MYSIDACEA
Mysidae
Lophogaster typicus
Paramysis helleri
Siriella clausi
Leptomysis longirostris
Leptomysis mediterranea
CUMACEA
Diastylidae
Diastylis rugosa
Bodotriidae
Iphinae serrata
ANISOPODA
Tanaidae
Tanais cavolini
ISOPODA
Cirolaninae
Evridice truncata
Anthuridae
Parasellidae
AMPHIPODA
Talitridae
Hyale schmidti
Ampeliscidae
Ampelisca diadema
Lysianassidae
Lysianassa longicornis
Gammaridae
Gammarus locustra
Elasmopus rapax
Dexaminidae
Tritaeta gibbosa
Carpellidae
Phtisica marina
BIVALVIA
Cardiacea
Cardium sp.
SCAPHOPODA
Dentalium sp.
PISCES
Gobiidae
Gobius sp.
Callionymidae
Callionymus sp.

Regional variations may be related to prey availability. In general, the food habits of the species is rather similar within all studied areas throughout the year. The proportion (by weight) of the major taxa in the diet of large scale gurnard sometimes varied markedly among areas. Mysids were by far the most important food in terms of number of individuals recorded, frequency of occurrence and biomass (Table III). This taxa contributed over 75% of the diet on a weight basis in the Thermaikos, Saronikos gulfs and the Thracian Sea almost all the year round, while, in the Pagassitikos Gulf, it reached respectively 84 and 70% during winter and spring. In this last area, decapods were the major food items during the two other seasons. In all other regions, decapods were the second most important food group, while amphipods were the third most numerous. Miscellaneous food items consumed included isopods, cumaceans, brachyurans, polychaetes and euphausiids. Algae were listed, although their occurrence probably represented accidental ingestion. The capture of fish prey suggested that large scale gurnard may also prey on small fish.

TABLE II: Number of stomachs examined (N), percentage of empty stomachs and weight of stomach contents of the large scale gurnard with season in the Greek seas.
F = fall, W = winter, S = spring, Su = summer. 0/000 = the ratio of the mean weight to stomach content to mean weight of individual in ten thousands.

Area	Saronikos Gulf				Pagassitikos Gulf				Thermaikos Gulf				Thracian Sea			
Season	F	W	S	Su	F	W	S	Su	F	W	S	Su	F	W	S	Su
N	135		140	162	85	53	54	78	57	79	118	49	128		269	30
% empty stomachs	14.1		11.4	10.5	8.2	26.4	9.2	6.4	10.5	26.6	15.2	6.1	39.8		10.4	3.3
0/000	36.5		91.7	76.9	28.5	26.4	29.2	36.5	47.4	27.1	55.4	73.2	31.8		59.8	79.1
Wgr/ind.	0.127				0.067				0.088				0.103			
Wgr/ind.	0.065	-	0.172	0.139	0.066	0.068	0.065	0.069	0.086	0.057	0.10	0.116	0.11	-	0.065	0.197

TABLE III: Importance of major prey taxa in the food of the large scale gurnard according to region. f= frequency of occurrence, Cw = percent by weight, Cn = percent by number, IRI = Index of Relative Importance, * = prey category present but <0.1% of the total weight.

Area	Thracian Sea				Thermaikos Gulf				Saronikos Gulf				Pagassitikos Gulf			
	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI
Algae	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	0.2	*
Polychaeta	0.3	*	*	*	1.2	0.4	0.5	1.1	1.0	0.5	0.2	0.7	-	-	-	-
Copepoda	0.9	-	0.2	0.2	0.4	-	*	*	0.3	-	*	*	1.7	-	0.3	0.5
Ostracoda	0.3	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
Euphausiacea	2.0	0.6	0.8	2.8	-	-	-	-	0.3	0.3	0.1	0.1	0.8	0.6	0.1	0.6
Amphipoda	25.6	5.5	10.1	399.4	12.2	2.9	2.3	56.1	13.3	1.9	2.6	60	28.4	7.1	9.6	47
Decapoda	26.2	10.4	8.4	487.3	22.8	15.8	12.1	636	22.3	10.1	13.7	531	38.9	30.7	21	
Brachyura	6.9	3.1	1.2	29.7	1.2	0.4	0.2	0.7	3.1	1.4	0.3	5.3	1.3	0.7	0.2	1.2
Mysidacea	80.4	75.1	71.8	11811	86.3	70.8	82.8	13255	82.1	76.3	80.4	12865	64.9	5		
Cumacea	17.6	3.7	7.3	193.6	4.7	0.9	1.7	12.2	3.4	1.6	2.0	12.2	5.0	1.0	1.3	11.5
Anisopoda					0.4	0.4	*	0.2	-	-	-	-	-	-	-	-
Isopoda	1.7	0.3	0.2	0.9	0.8	0.2	0.2	0.3	2.9	0.5	0.6	3.2	-	-	-	-
Scaphopoda									0.3	*	0.1	*	-	-	-	-
Bivalvia									0.3	*	*	*				
Pisces	0.3	0.1	*	*					0.5	0.3	0.1	0.2	-	-	-	-
Detritus	2.9	1.3	-	3.8	9.8	8.2	-	80.4	8.3	7.1		59	12.6	8.2	-	103.3

We examined geographical changes in IRI to detect which prey could account for significant differences in large scale gurnard diet. There is a reduction in the importance of mysids and an increase of decapods in the Pagassitikos Gulf, which reflect the geographical changes in the large scale gurnard diet observed during winter and spring.

A complete list of mysids prey items in term of numbers, weight and frequency was presented by geographical area in Table IV. *Lophogaster typicus* and *Paramysis helleri* were the dominant mysids consumed, while *Siriella clausi* and *Leptomysis mediterranea* were of secondary importance. The presence of *L. typicus* was more marked in the Saronikos Gulf and the Thracian Sea, while *P. helleri* occurred in all the areas studied, but more so in the Thermaikos Gulf.

Seasonal differences

The seasonal differences in the diet of large scale gurnard were summarized in Table V. The seasonal variation in feeding activity was investigated by following the proportion of stomachs which contained food each season: the highest intensity of feeding was found in summer according to the lower frequency of empty stomachs and the highest weights of stomach contents. A comparison (Table II) between the quantity of food in the stomachs during each season revealed that, in summer, large scale gurnard consumed almost twice as much food (on an average) than fish caught in winter ("t" test, $P < 0.05$).

The food habits exhibited only slight seasonal variation regarding the principal preys (Table V). Mysids were the dominant food during all seasons, always occurring in more than 75% of the fishes and contributing no more than 70% of the total prey weight. Decapods decreased in importance in winter, while there was an increase in the proportion by weight of mysids, the dominant food item for large scale gurnard during the whole year. Amphipods occurred frequently in spring, but contributed little by weight.

The seasonal change in IRI between the dominant (mysids) and secondary food (decapods) was related to weight percentages: increase in the importance of mysids in winter and fall, with corresponding decrease in decapods, while the reverse occurred in spring and summer. The importance of mysids in winter was exaggerated by their high frequency of occurrence.

The mysids *L. typicus* and *P. helleri* were the principal prey; the first one peaked in spring, then gradually diminished and was replaced by the second species in winter (Table VI). *L. mediterranea* and *S. clausi* contributed little to the diet of large scale gurnard and did not exhibit significant seasonal variation.

Overlap and feeding habits

Schoener's (1970) index values of dietary overlap indicated high overlap between seasons and between regions (Table VII). The overlap was calculated on a weight basis, which may be a better measure of the energy obtained from the various food items. The small variation in the overlap values: summer-fall (0.95) and winter-spring (0.86) suggest no seasonal variation in prey availability. The overlaps between the geographical areas were also high and varied between 0.71 and 0.92. The low difference in the relative contribution of mysids and decapods and the almost insignificant contribution of amphipods, isopods, cumaceans etc, explain to the very high overlap values between seasons and areas. The only interpretation for the lower values of the overlap between the Pagassitikos and the other three areas is the change in availability of both predator and prey (mysids, decapods) in the Pagassitikos Gulf, as well as the lower food abundance.

TABLE IV: Geographical variation of mysids species in composition of diet of the large scale gurnard by frequency of occurrence (f), percent by weight (Cw), percent by number (Cn) and Index of Relative Importance (IRI).

Area	Thracian Sea				Thermaikos Gulf				Saronikos Gulf				Pagassitikos Gulf			
	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI
L. typicus	59.7	65.0	29.5	5642	40.8	41.4	12.6	2203	40.0	66.8	57.5	4972	12.6	21.7	7.6	369
P. helleri	30.8	33.8	68.0	3135	69.8	44.8	71.5	8118	54.8	33.2	42.5	4148	34.7	44.0	40.9	2946
L. longic	2.0	1.2	2.5	7.4	-	-	-	-	-	-	-	-	-	-	-	-
L. mediterranea	0.3	0.1	0.1	*	5.5	3.0	13.6	91.3	-	-	-	-	6.7	3.7	9.2	86
S. clausi	-	-	-	-	3.5	8.3	1.9	35.7	-	-	-	-	11.3	20.8	40.3	690
Mysidacea	-	-	-	-	1.2	2.5	0.5	3.6	-	-	-	-	5.9	9.8	2.0	70

TABLE V: Importance of major prey taxa in the food of the large scale gurnard according to season.
f= frequency of occurrence, Cw = percent by weight and Cn = percent by number, IRI = Index of Relative Importance, * = prey category present but <0.1% of the total weight.

Season	Spring				Summer				Fall				Winter			
	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI
Algae	-	-	-	-	-	-	-	-	*	*	-	*	-	-	-	-
Polychaeta	1.6	0.6	0.4	1.6	-	-	-	-	-	-	-	-	-	-	-	
Ostracoda	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	-
Copepoda	1.0		0.3	0.3	0.7	-	*	*	*	*	*	*	1.0	-	0.2	0.2
Euphausiacea	1.6	0.6	0.7	2.1	-	-			0.6	0.4	0.1	0.3	-	-	-	-
Anisopoda	0.2	*	*	*					-	-	-	-	-	-	-	-
Isopoda	1.4	0.4	0.5	1.3	2.0	0.3	0.2	1.0	1.9	0.2	0.3	1.0	-	-	-	-
Amphipoda	26.5	5.3	11.7	450	17.1	2.4	3.3	97.5	18.1	2.6	3.3	107	11.3	3.1	3.8	78.
Cumacea	12.1	2.5	6.6	110	4.8	2.3	2.4	22.6	2.2	0.8	1.2	4.4	5.1	1.0	1.3	11.7
Mysidacea	75.7	68.9	65.6	10182	78.5	72.2	71.0	11241	81.1	76.3	90.1	13495	92.8	82.0	89.7	15934
Decapoda	23.9	11.9	13.0	595	35.2	16.5	22.7	1380	29.7	14.4	5.0	576	21.6	12.5	4.5	367
Brachyura	5.6	2.5	1.1	20.2	2.7	1.3	0.3	4.3	0.9	0.3	0.1	0.33	3.1	1.4	0.6	6.2
Scaphopoda	-	-	-	-	0.3	*	*	*	-	-	-	-	-	-	-	-
Bivalvia					0.3	*	*	*								
Pisces	0.6	0.3	0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	8.9	7.1	-	63.2	8.2	5.0	-	41.0	11.6	4.9	-	57	-	-	-	-

TABLE VI: Seasonal variation of mysids species in composition of the diet of the large scale gurnard by frequency of occurrence (f), percent by weight (Cw), percent by number (Cn) and Index of Relative Importance (IRI).

Season	Spring				Summer				Fall				Winter			
	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI	f	Cw	Cn	IRI
L. typicus	40.5	76.1	37.2	4589	43.3	59.9	26.5	3741	40.4	23.5	36.6	2428	24.7	32.9	8.4	1020
P. helleri	41.0	18.4	35.2	2198	43.7	33.9	64.9	4318	52.2	75.7	63.4	7261	74.2	61.9	88.0	11127
L. longic	1.4	0.8	2.3	4.3	-	-	-	-	-	-	-	-	-	-	-	-
L. mediterranea	3.5	1.5	9.4	38	4.1	0.9	4.7	23.0	-	-	-	-	1.0	0.5	0.2	0.7
S.clausi	4.1	2.8	15.6	75	4.4	3.1	3.6	29.5	-	-	-	-	2.1	0.5	1.5	4.2
Mysidacea	0.2	0.4	0.3	0.1	1.4	2.2	0.2	3.4	0.9	0.8	2	0.7	6.2	4.3	1.9	38.4

TABLE VII: Dietary overlap matrix of the large scale gurnard for the four geographical areas and the four seasons. The figures in the tables are values for the overlap coefficient as calculated from the SCHOENER formula.

Area	Thracian	Thermaikos	Saronikos	Pagassitikos
Thracian	-	0.87	0.92	0.71
Thermaikos		-	0.92	0.80
Saronikos			-	0.73
Pagassitikos				

Season	Spring	Summer	Fall	Winter
Spring	-	0.92	0.90	0.86
Summer		-	0.95	0.89
Fall			-	0.87
Winter				

DISCUSSION

A significant drop of empty stomachs was observed during summer with a relative increase in the mean weight of stomach contents. This was not true for the Pagassitikos Gulf, where no significant seasonal difference was found. Significant differences in the mean weight of the stomach contents between the areas were found. The increase in a seasonal cycle in food intake during spawning time in spring-summer in all Greek seas or the absence of this in the Pagassitikos Gulf, as suggested by the empty stomachs and the mean weight of the stomach contents was in contrast with most information available in literature, where it was generally stated that feeding diminished during spawning (Le Cren, 1951; Tesch, 1971; Nikolsky, 1976).

The Triglidae feed essentially on crustaceans and particularly on mysids and decapods (Rey, 1960). Large scale gurnard is part of a feeding guild of marine demersal fishes which utilize heavily, if not exclusively, benthic or epibenthic organisms of appropriate size, such as mysids, decapods, amphipods and cumaceans. The relative low percentage of debris in the stomachs contents suggested that large scale gurnard was not a detritus feeder. The results obtained from this study on the food spectrum of large scale gurnard in Greek seas agree with those of Kartas (1971) in the Gulf of Lion. He reported *L. typicus* and *Anchialina agilis* as the most important prey in winter and *Erythrops erythrophthalmus* and *A. agilis* in summer. The last one is common in the Thracian Sea, but it has not been reported from Saronikos, Pagassitikos and Thermaikos gulfs (Hatzakis, 1982). *E. erythrophthalmus* is not reported in Greek seas. Kartas (1971) concluded that the species fed actively all the year round, but that more food was eaten during summer than winter. Even though we have drawn the same conclusion as Kartas, his study is not directly comparable with the present one, because he presented the diet by the frequency of occurrence of prey, not by weight.

The stomach contents of large scale gurnard indicate that the species is a selective predator, as it is dependent on almost one or two specific food organisms. Among the different areas and seasons considered here, only one feeding pattern is observed assuming that the same prey items are equally available to all individuals. Availability depends not only on prey abundance, but also on the interaction of other factors, including prey size, microdistribution, capture success and speed of movement (Bailey and Harrison, 1948; Griffiths, 1975). Although polychaetes and mollusks dominated in the sediments, mysids were the preferred consumed prey that were active either at the sediment surface or in the upper few centimetres of sediments. According to Hatzakis (1982), catch rates of mysids along the Greek coasts were the highest near the bottom during the day and at the surface a few hours later (night).

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